

### **REMARKS**

The Examiner has rejected claims 15-17, 19, 22-28, 30 and 31 under 35 U.S.C. § 102(e) as being anticipated by Butt et al. U.S. Patent No. 5,817,972. Claims 20, 21, 29, 32 and 33 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Butt et al. in view of Jacob et al. DE 19531130 A1. The following remarks are respectfully submitted.

With respect to the rejection under § 102, Applicants respectfully traverse. The Examiner takes the position that Butt et al.'s method of dry blending and then compacting the components is the equivalent of grinding. The term grinding implies, by definition, a reduction in particle size to a fine particle. Dry blending simply means blending components together without a liquid and compacting is merely pressing under pressure, neither of which implies a reduction in particle size. To further clarify that the grinding involves a reduction in particle size, claim 15 has been amended to specify that the "grinding is for a time sufficient to form a mixture having an average grain size of less than 20  $\mu\text{m}$ ." Butt et al. do not disclose a method that involves grinding to form a mixture having an average grain size of less than 20  $\mu\text{m}$ . Therefore, there is no anticipation of the claims. Applicants therefore request withdrawal of the rejection under § 102(e) of claims 15-17, 19, 22-28, 30 and 31.

With respect to the rejection under § 103, Applicants respectfully traverse. Although claim 21 has been canceled herein, the element of grinding to an average grain size of less than 20  $\mu\text{m}$  has been added to independent claim 15. This element is also present in independent claim 32. It is the Examiner's position that Butt et al. do not disclose a grain size of less than 20 microns, but that Jacob et al. disclose a mixture of nitroguanidine with iron oxide with a grain size of less than 20 microns, such that it would be obvious to one of ordinary skill in the art to modify the method of Butt et al. by having a grain size of less than 20 microns as disclosed by Jacob et al. However, in column 4 of Butt et al., beginning at line 35, Butt et al. disclose that the particle size of the iron oxide fraction is important, and preferably consists of a major portion which is substantially free of fine particle size material. By "fine particle size

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material," they mean catalytic grade or paint grade material having an average particle size of 2 microns or less, and by "major portion," they mean more than 50%. At lines 63-64, Butt et al. state "preferably, the iron oxide fraction has a major portion which has an average particle size greater than 100 microns." Butt et al. again state at column 7, lines 57-62, that "Preferably, a major portion (more than about 50% by weight) of the iron oxide fraction has a narrow particle size distribution curve and is substantially free of catalytic or paint grade iron oxide. Preferably, at least about 50% of the iron oxide fraction has an average particle size greater than about 100 microns." Therefore, Butt et al. teach against grinding to an average particle size of less than 20 microns. "A prior art reference must be considered in its entirety, i.e., as a whole, including portions that would lead away from the claimed invention." MPEP § 2141.02 (citing *W.L. Gore & Assoc., Inc. v. Garlock, Inc.*, 221 USPQ 303 (Fed. Cir. 1983), *cert denied*, 469 U.S. 851 (1984)). Considering each reference as a whole, and the prior art as a whole, there is no teaching, suggestion or motivation to combine the Butt et al. and Jacobs et al. references to arrive at the present invention as claimed. It is therefore respectfully requested that the rejection under § 103 of claims 20, 21, 29, 32 and 33 be withdrawn.

For the Examiner's convenience, a glossary of terms from the Engineered Materials Handbook is enclosed herewith, including definitions for grinding versus dry blending. Note also that dry blending is distinguished from dry grinding. Compaction is also defined as merely the act of forcing particulate or granular material under pressure or impact, and this does not involve a reduction in particle size.

In view of the foregoing amendments to the claims and remarks given herein, Applicants respectfully believe this case is in condition for allowance and respectfully request allowance of the pending claims. If the Examiner believes any detailed language of the claims requires further discussion, the Examiner is respectfully asked to telephone the undersigned attorney so that the matter may be promptly resolved. The Examiner's prompt attention to this matter is appreciated.

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Applicants are of the opinion that no additional fee is due as a result of this Amendment. If any charges or credits are necessary to complete this communication, please apply them to Deposit Account No. 23-3000.

Respectfully submitted,

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ture or as a more complicated equation applicable to a wide range of temperatures.

**coercive field** ( $E_c$  or  $e_c$ ). The negative electrical or magnetic field needed to make remanent polarization or magnetization vanish in a ferroelectric or ferromagnetic material.

**coercive force.** The magnetizing force that must be applied in the direction opposite to that of the previous magnetizing force in order to reduce magnetic flux density to zero; thus, a measure of the magnetic retentivity of magnetic materials.

**cohesion.** (1) The state in which the particles of a single substance are held together by primary or secondary valence forces. As used in the adhesive field, the state in which the particles of the adhesive (or adherend) are held together. (2) Force of attraction between the molecules (or atoms) within a single phase. Contrast with *adhesion*.

**cohesive blocking.** The blocking of two similar, potentially adhesive faces.

**cohesive failure.** Failure of an adhesive joint occurring primarily in an adhesive layer. Compare with *adhesive failure*.

**cohesive strength.** (1) The hypothetical stress causing tensile fracture without plastic deformation. (2) The stress corresponding to the forces between atoms. (3) Intrinsic strength of an adhesive.

**coin test.** Using a coin to tap a laminate in different spots, listening for a change in sound, which would indicate the presence of a defect. A surprisingly accurate test in the hands of experienced personnel.

**coke.** Carbonaceous residue resulting from the pyrolysis of pitch.

**Colburn process.** A method of forming flat glass in which a ribbon of molten glass is drawn upward from the glass tank, rolled flat, annealed, and then cut into desired sizes and shapes.

**cold drawing.** Technique for using standard metal-working equipment and systems for forming thermoplastic sheet at room temperature.

**cold-end coating.** The process of adding a thin layer of polymetric material to a glass bottle outer surface as it leaves the annealing lehr to increase its lubricity and improve the scratch resistance. Water-based polyethylene emulsions are commonly used because they can be applied by spraying.

**cold flow.** The distortion that takes place in polymeric materials under continuous load at temperatures within the working range of the material without a phase or chemical change.

**cold molding.** A procedure in which a plastic is shaped at room temperature and subsequently cured by baking.

**cold parison blow molding.** A plastic forming technique in which parisons are extruded or injection molded separately and then stored for subsequent transportation to the blow molding machine for blowing. See also *blow molding*.

**cold pressing.** A bonding operation in which a plastic assembly is subjected to pressure without the application of heat.

**cold-press molding.** A plastic molding process in which inexpensive plastic male and female molds are used with room-temperature curing resins to produce accurate parts. Limited runs are possible.

**cold-runner molding.** In plastic part making, a mold in which the sprue-and-runner system (the manifold section) is insulated from the rest of the mold and temperature-controlled to keep the plastic in the manifold fluid. This mold design eliminates scrap loss from sprues and runners.

**cold-setting adhesive.** An adhesive that sets at temperatures below 20 °C (68 °F). See also *hot-setting adhesive*, *intermediate-temperature-setting adhesive*, and *room-temperature-setting adhesive*.

**cold slug.** The first plastic material to enter an injection mold; so called because in passing through a sprue orifice it is cooled below the effective molding temperature.

**cold-slug well.** In plastic part making, the space provided directly opposite the sprue opening in an injection mold to trap the cold slug.

**cold stretch.** A pulling operation with little or no heat, usually on extruded filaments, to increase tensile properties of composite materials.

**collapse.** Inadvertent densification of cellular plastic material during manufacture resulting from the breakdown of cell structure.

**colligative properties.** Properties of plastics based on the number of molecules present. Most important are certain solution properties extensively used in molecular weight characterization.

**collimated.** Rendered parallel.

**collimated roving.** Roving for reinforced plastics that has been made using a special process (usually parallel wound), such that the strands are more parallel than in standard roving.

**colloid.** A stable (nonsettling) suspension of some material within a fluid host, the dimensions of the former usually being about  $\leq 1 \mu\text{m}$ . Fogs, smokes, foams, emulsions, sols, and gels are examples.

**colloidal.** A state of suspension in a liquid medium in which extremely small particles are suspended and dispersed but not dissolved.

**colloidal clay.** A very fine natural clay that usually swells when it takes up water and that is used as a binder for nonplastic materials.

**color concentrate.** A measured amount of dye or pigment incorporated into a predetermined amount of plastic. The pigmented or colored plastic is then mixed into larger quantities of plastic material to be used for molding. This mixture is added to the bulk of plastic in measured quantity in order to produce a precise, predetermined color of finished articles to be molded.

**combination mold.** See *family mold*.

**combing.** Lining up of reinforcing fibers.

**comminution.** The act or process of reducing the particle size of a material.

**compaction.** (1) The act of forcing particulate or granular material together (consolidation) under pressure or impact to yield a relatively dense mass or formed object. Usually followed by drying, curing, or firing in refractory or other ceramic or powder metallurgy processing. (2) In ceramics or powder metallurgy, the preparation of a compact or object produced by the compression of a powder, generally while confined in a die, with or without the inclusion of lubricants, binders, and so forth, and with or without the concurrent applications of heat. (3) In reinforced plastics and composites, the application of a temporary vacuum bag and vacuum to remove trapped air and compact the lay-up.

**compatibility.** The ability of two or more substances combined with one another to form a homogeneous composition having useful plastic properties; for example, the suitability of a sizing or finish for use with certain general resin types. Nonreactivity or negligible reactivity between materials in contact.

**complexation.** The formation of complex chemical species by the coordination of groups of atoms termed ligands to a central ion, commonly a metal ion. Generally, the ligand coordinates by providing a pair of electrons that forms an ionic or covalent bond to the central ion. See also *chelate*, *coordination compound*, and *ligand*.

**complex modulus.** The ratio of stress to strain in which each is a vector that may be represented by a complex number. May be measured in tension or flexure, compression, or shear.

**complex shear modulus.** The vectorial sum of the shear modulus and the loss modulus.

**complex Young's modulus.** The vectorial sum of Young's modulus and the loss modulus.

**compliance.** Tensile compliance is the reciprocal of Young's modulus. Shear compliance is the reciprocal of shear modulus. The term is also used in the evaluation of stiffness and deflection.

**composite material.** A combination of two or more materials (reinforcing elements, fillers, and composite matrix binder), differing in form or composition on a macroscale. The constituents retain their identities, that is, they do not dissolve or merge completely into one another although they act in concert. Normally, the components can be physically identified and exhibit an interface between one another. See also *carbon-carbon composites*, *ceramic-matrix composites*, *metal-matrix composites*, and *resin-matrix composites*.

**compound.** (1) In chemistry, a substance of relatively fixed composition and properties, whose ultimate structural unit (molecule or repeat unit) is comprised of atoms of two or more elements. The number of atoms of each kind in this ultimate unit is determined by natural laws and is part of the identification of the compound. (2) In reinforced plastics and composites, the intimate admixture of a polymer with other ingredients, such as fillers, softeners, plasticizers, reinforcements, catalysts, pigments, or dyes. A thermoset compound usually contains all the ingredients necessary for the finished product, while a thermoplastic compound may require subsequent addition of pigments, blowing agents, and so forth.

**compression molding.** A technique of thermoset molding in which the plastic molding compound (generally preheated) is placed in the heated open mold cavity, the mold is closed under pressure (usually in a hydraulic press), causing the material to flow and completely fill the cavity, and then pressure is held until the material has cured.

**compression ratio.** In an extruder screw, the ratio of the volume available in the first flight at the hopper to the volume at the last flight, at the end of the screw.

**compressive modulus.** The ratio of compressive stress to compressive strain below the proportional limit. Theoretically equal to Young's modulus determined from tensile experiments.

**compressive strength.** The maximum compressive stress that a material is capable of developing, based on original area of cross section. If a material fails in compression by a shattering fracture, the compressive strength has a very definite value. If a material does not fail in compression by a shattering fracture, the value obtained for compressive strength is an arbitrary value depending upon the degree of distortion that is regarded as indicating complete failure of the material.

**compressive stress.** A stress that causes an elastic body to deform (shorten) in the direction of the applied load. Contrast with *tensile stress*.

**Compton scattering.** In materials characterization, the elastic scattering of photons by electrons. Contrast with *Rayleigh scattering*.

**conchoidal fracture.** Shell-like fracture pattern characteristic of amorphous materials. It contains mirror, mist, and hackle zones spreading out from the point of initial failure.

**concrete.** (1) A composite material that consists essentially of a binding medium within which are embedded particles or fragments of aggregates (maximum aggregate size  $> 5 \text{ mm}$ , or 0.2 in.). In hydraulic-cement concrete, the binder is formed from a mixture of hydraulic cement and water. (2) A homogeneous mixture of portland cement, aggregates, and water and which may contain admixtures.

**concrete aggregate.** Sand, gravel, crushed rock, slag, and similar materials blended with portland cement to form concrete.

pecially at radii) relative to their idealized location, due to motion during lay-up and cure.

**doctor blade or bar.** (1) In forming plastics, a straight piece of material used to spread resin, as in application of a thin film of resin for use in hot-melt prepregging or for use as an adhesive film. Also called paste metering blade. (2) A flat metal knife on a device used to spread a uniform thickness of material on a surface and to remove excess material from the surface (e.g., scraping excess coloring pastes from roller coats).

**doctor mark.** A defect on a surface coating which looks like a ridge, caused by a damaged doctor blade.

**doctor roll.** In applying adhesives, a roller mechanism that is revolving at a different surface speed, or in an opposite direction, resulting in a wiping action for regulating the adhesive supplied to the spreader roll.

**doghouse.** A small boxlike vestibule on a glass furnace into which batch is fed or which facilitates the introduction and removal of floaters.

**doily.** In filament winding of composites, the planar reinforcement applied to a local area between windings to provide extra strength in an area where a cutout is to be made, for example, port openings. Usually placed at the knuckle joints of cylinder to dome.

**dolomite.** Mineral of composition  $\text{CaMg}(\text{CO}_3)_2$  used in refractories, glass, tile, and pottery bodies, and also in glazes, primarily as a fluxing ingredient.

**domain.** A morphological term used in noncrystalline systems, such as block copolymers, in which the chemically different sections of the chain separate, generating two or more amorphous phases.

**dome.** In filament winding, the portion of a cylindrical container that forms the spherical or elliptical shell ends of the container.

**domed.** Showing a symmetrical distortion of a flat or curved section of a plastic object so that, as normally viewed, it appears convex, or more convex than intended.

**dopant.** (1) A material added to a polymer to change a physical property. (2) An impurity introduced under highly controlled conditions in very small but accurately known quantities into a semiconductor material, such as silicon. Dopants modify the electrical characteristics of the silicon by creating *p* or *n* regions and hence *pn* junctions.

**Doppler effect.** The change in the observed frequency of an acoustic or electromagnetic wave due to the relative motion of source and observer.

**dosimeter.** A device for measuring radiation-induced signals that can be related to absorbed dose (or energy deposited) by radiation in materials and is calibrated in terms of the appropriate quantities and units. Also called dose meter.

**double-gob process.** The process of forming two glass items simultaneously.

**doubler.** In filament winding of composites, a local area with extra reinforcement, wound integrally with the part, or wound separately and fastened to the part. See also *nibs*.

**double-shot molding.** In forming plastics, a means of producing two-color parts and/or two different thermoplastic materials by successive molding operations.

**double spread.** The application of adhesive to both adherends of a joint.

**downdraft kiln.** A kiln in which the hot gases from the firebox are passed to the crown, then directed through the ware being fired, and finally are exhausted into a flue or stack.

**downdraw.** The process of continuously drawing glass downward from an orifice.

**downfeed.** The rate at which the grinding wheel is fed into the work when surface grinding to shape a ceramic.

**draft.** (1) The difference in pressure that causes air and combustion gases to flow from one area to another, such as from a furnace, kiln, or dryer to a flue. (2) An angle or taper on the surface of a pattern, core box, punch, or die (or of the parts made with them) that facilitates removal of the parts from a mold or die cavity, or a core from a casting. (3) The change in cross section that occurs during rolling or cold drawing.

**draft angle.** The angle of a taper on a mandrel or mold that facilitates removal of the finished plastic part.

**drain casting.** The forming of a ceramic body by pouring slip into a porous mold and then draining the slip from the mold after the cast body has attained the desired thickness.

**drape.** In fabricating composites, the ability of a fabric or prepreg to conform to a contoured surface.

**drape forming.** Method of forming thermoplastic sheet in which the sheet is clamped into a movable frame, heated, and draped over high points of a male mold. Vacuum is then pulled to complete the forming operation. Also known as basic male mold forming.

**draw.** (1) The quantity of glass delivered by a glass-melting tank per unit of time; usually 24 h. (2) To remove a charge of fired ware from a kiln. (3) The draft in a flue.

**draw-down ratio.** In forming plastics, the ratio of the thickness of the die opening to the final thickness of the product.

**draw firing.** Removal of a load from a porcelain-enameling furnace prior to completion of the firing operation to permit equalization of the heat in the ware, particularly in areas of greater thickness; the load may, or may not, be returned to the furnace, depending on the degree of maturity of the coating.

**drawing.** The process of stretching a thermoplastic to reduce its cross-sectional area, thus creating a more orderly arrangement of polymer chains with respect to each other.

**drawn fiber.** Fiber for reinforced plastics with a certain amount of orientation imparted by the drawing process by which it is formed.

**dredging.** The application of powdered, porcelain-enamel frit to a hot metal shape, usually cast iron, by sifting the powder over the surface of the metal.

**dropping.** The shaping of a glass article by sagging heat-softened glass into a mold without the application of mechanical pressure.

**drop throat.** The throat of a glass tank situated below the level of the bottom or floor of the melting tank.

**dress.** (1) The scum that forms on the surface of molten metal largely because of oxidation but sometimes because of the rising of impurities to the surface. (2) Oxide and other contaminants that form on the surface of molten solder.

**dry.** To change the physical state of an adhesive on an adherend by the loss of solvent constituents by evaporation or absorption, or both. See also *cure* and *set*.

**dry-bag isostatic pressing.** A forming method in which the sealing envelope is permanently sealed into a pressure vessel to facilitate loading, pressing, and product removal.

**dry blend.** Refers to a plastic molding compound containing all necessary ingredients mixed in a way that produces a dry, free flowing, particulate material. This term is commonly used in connection with polyvinyl chloride molding compounds.

**dry bond adhesive.** See *contact adhesive*.

**dry coloring.** Method commonly used by fabricators for coloring plastics by tumble blending uncolored particles of the plastic material with selected dyes and pigments.

**dry edging.** An imperfection consisting of rough edges and corners on glazed ceramic ware due to insufficient application of glaze to the area.

**dry fiber.** In composites fabrication, a condition in which fibers are not fully encapsulated by resin during pultrusion.

**dry gauge.** Cullet produced by ladling molten glass from a melting unit into water.

**dry grinding.** Milling of materials without a liquid medium.

**drying.** Removal, by evaporation, of uncombined water or other volatile substance from a ceramic raw material or product, usually expedited by low-temperature heating.

**drying control chemical additives.** Chemicals added to gels which speed up the drying process. The mechanism is unclear but it may be the fact that the chemicals make the capillary stress uniform by narrowing the distribution of pore sizes.

**drying temperature.** The temperature to which an adhesive on an adherend, an adhesive in an assembly, or the assembly itself is subjected to dry the adhesive. The temperature attained by the adhesive in the process of drying (adhesive drying temperature) may differ from the temperature of the atmosphere surrounding the assembly (assembly drying temperature). See also *curing temperature* and *setting temperature*.

**drying time.** The period of time during which an adhesive on an adherend or an assembly is allowed to dry with or without the application of heat or pressure, or both. See also *curing time*, *joint-conditioning time*, and *setting time*.

**dry laminate.** A laminate containing insufficient resin for complete bonding of the reinforcement. See also *resin-starved area*.

**dry lay-up.** Construction of a laminate by the layering of preimpregnated reinforcement (partly cured resin) in a female mold or on a male mold, usually followed by bag molding or autoclave molding. See also *vacuum bag molding*.

**dry pressing.** The process of forming or shaping ceramic bodies of low moisture content (5 to 10% water) by compression in molds.

**dry process.** (1) A process for manufacturing portland cement in which the batch is charged into the cement kiln in the dry state. (2) To process concrete aggregate without the use of water.

**dry-process enameling.** A process of porcelain-enameling in which the base metal, usually cast iron, is heated to a temperature slightly above the fusion temperature of the enamel, followed by sifting finely powdered enamel frit on the metal surface or by dipping the hot metal into a dry batch of powdered frit, and then firing the coating to maturity; the process may be repeated with minimal cooling of the ware until the desired coating thickness is attained.

**dry strength.** (1) The strength of an adhesive joint determined immediately after drying under specified conditions or after a period of conditioning in the standard laboratory atmosphere. See also *wet strength*. (2) The resistance of a dried but unfired ceramic body to physical or mechanical damage.

**dry tack.** The property of certain adhesives, particularly nonvulcanizing rubber adhesives, to adhere on contact to themselves at a stage in the evaporation of volatile constituents, even though they seem dry to the touch. Synonym for aggressive tack.

**dry winding.** In composites fabrication, filament winding using preimpregnated roving, as differentiated from wet winding, in which unimpregnated roving is pulled through a resin bath just before being wound onto a mandrel. See also *wet winding*.

**DSC.** See *differential scanning calorimetry*.

**glass wool.** A randomly oriented, fleecy mass of glass fibers used for acoustic and thermal insulation, air filters, and similar applications. Made by blowing air at coarse molten glass filaments.

**glassy.** A state or matter that is amorphous or disordered like a liquid in structure, hence capable of continuous composition variation and lacking a true melting point, but softening gradually with increasing temperature. Glasses of commerce are mainly complex silicates in chemical combination with numerous other oxidic substances; made by melting the source materials together, forming in various ways while fluid, and allowing to cool.

**glaze.** A ceramic coating matured to the glassy state on a formed ceramic article, or the material or mixture from which the coating is made.

**glaze fit.** The stress relationship between the glaze and body of a fired ceramic, that is, the degree to which the coefficients of expansion of the two components are matched.

**glaze flow.** (1) The property of a glaze slip to flow over the surface of a ceramic body to form a smooth, uniform coating. (2) The property of glaze ingredients to flow together to form a smooth, impervious coating during firing.

**glaze stains.** Calcined ceramic pigments, usually metal oxides, incorporated in a glaze slip to produce a coating of uniform color; some serve essentially as pigments, some as precipitates, and some go into solid solution in the fired glaze.

**glazing.** (1) The application of a glaze to ceramic ware. (2) The cutting and fitting of glass panes into frames, and the application of a caulking compound to seal the panes in place.

**gloss.** The polish, luster, or brilliance of a fired porcelain enamel or glaze coating; the ratio of specularly reflected light to the total light reflected by a surface.

**glossmeter.** An instrument to measure the degree of gloss which works by shining light from a standard source at 45° onto the surface and the reflected light is measured by its effect on a photoelectric cell.

**glost.** A synonym for glazed. See also *glost firing*.

**glost firing.** A kiln firing process, usually carried out at moderate to low temperatures, to which bisque ware, covered in unfired glaze compound, is subjected.

**glucose.** A monosaccharide,  $C_6H_{12}O_6$ , used as a binder.

**glue.** Originally, a hard gelatin obtained from hides, tendons, cartilage, bones, and so on, of animals and also an adhesive prepared from this substance by heating with water. Through general use, the term is now synonymous with the terms bond and adhesive. See also *adhesive, gum, mastic, paste, resin, and sizing*.

**glue-laminated wood.** An assembly made by bonding layers of veneer or lumber with an adhesive so that the grain of all laminations is essentially parallel.

**glue line.** Synonym for *bond line*.

**glue line thickness.** Thickness of layer of cured adhesive.

**gob.** (1) A portion of hot glass delivered by a feeder. (2) A portion of hot glass gathered on a punty or pipe.

**gob process.** A process whereby glass is delivered to a forming unit in gob form.

**gpd.** Abbreviation for grams per denier, a measure of fiber strength. Converted to SI units of  $N/m^2$  by the equation  $\sigma (N/m^2) = 0.08826 p$  [stress in gpd], where  $p$  is the fiber density in  $g/cm^3$ . See also *tenacity*.

**grade.** An index of friability of bonded abrasives.

**graft copolymers.** A chain of one type of polymer to which side chains of a different type are attached or grafted.

**grain.** (1) Any small hard particle such as an abrasive grain or a grain of sand. (2) An individual crystal in a polycrystalline material; it may or may not contain twinned regions and subgrains.

**grain boundary.** A narrow zone in a metal or ceramic corresponding to the transition from one crystallographic orientation to another, thus separating one grain from another; the atoms in each grain are arranged in an orderly pattern.

**grain boundary diffusion.** One of the diffusion mechanisms in sintering. It is characterized by a very high diffusion rate because of an abundance of imperfections in the grain boundaries. See also *surface diffusion* and *volume diffusion*.

**grain boundary migration.** A sideways movement of the grain, that is, grain growth.

**grain boundary sliding.** Relative motion of two grains parallel to the grain boundary.

**grain growth.** (1) An increase in the average size of the grains in polycrystalline material, usually as a result of heating at elevated temperature. (2) In polycrystalline materials, a phenomenon occurring fairly close below the melting point in which the larger grains grow still larger while the smallest ones gradually diminish and disappear.

**grain growth rate.** The average increase in grain size experienced during the final stage of sintering; follows the function  $d_f^2 - d_0^2 = kt$ , where  $d_f$  is the average grain diameter,  $d_0$  is the starting average grain diameter,  $k$  is a constant, and  $t$  is the elapsed time. The grain growth rate exponentially increases with temperature.

**grain size.** The average size of particulate materials used in the production of ceramic ware, often simply determined by screen analysis.

**granular structure.** Nonuniform appearance of finished plastic material due to retention of, or incomplete fusion of, particles of composition, either within the mass or on the surface.

**granulated blast-furnace slag.** Glassy, granular structure material made when molten blast-furnace slag is quenched in water.

**granulation dry pressing.** A method of preparing and forming tableware that requires little drying before firing. Powdered clay, stone, and calcined bone are mixed as a spray-dried powder which is then granulated to a 2% moisture agglomerate. The agglomerate is then dry-pressed against a steel die by an oil-filled membrane.

**graphite.** (1) A crystalline allotropic form of carbon. (2) Uncombined carbon in cast irons.

**graphite brick.** A refractory ceramic brick formed from coke and pitch, heat treated above 2500 °C (4530 °F) in an inert atmosphere to form crystallites of graphite.

**graphite fiber.** A fiber made from a pitch or polyacrylonitrile (PAN) precursor by an oxidation, carbonization, and graphitization process (which provides a graphitic structure). See also *carbon fiber*.

**graphitization.** The process of pyrolyzation in an inert atmosphere at temperatures in excess of 1925 °C (3500 °F), usually as high as 2480 °C (4500 °F), and sometimes as high as 5400 °C (9750 °F), converting carbon to its crystalline allotropic form. Temperature depends on precursor and properties desired.

**green density.** The density of an unsintered compact.

**green glass.** (1) Glass in its natural color; usually greenish from metallic impurities. (2) Glass made green by adding copper oxide to a clear glass batch.

**green machining.** A technique developed to minimize the final grinding to shape and size of sintered ware, whereby the powder is cold isostatically pressed to a density which enables a shape to be ground from the blank before sintering.

**green strength.** The mechanical strength of material, that, while cure is not complete, allows removal from the mold and handling without tearing or permanent distortion.

**greenware.** A term for formed ceramic articles in the unfired condition.

**greige, gray goods.** Any fabric before finishing, as well as any yarn or fiber before bleaching or dyeing; therefore, fabric with no finish or size.

**Griffith equation.** A seminal equation focusing attention on the relationship between strain energy, surface energy, flaws, and strength of brittle solids;  $\sigma = (2E\gamma/\pi c)^{1/2}$ , where  $\sigma$  is the breaking stress,  $E$  is Young's modulus,  $\gamma$  is the specific surface energy, and  $c$  is one-half the length of the critical flaw which propagates to cause failure.

**Griffith flaw.** A microscopically small crack believed to exist on the surface of glass and ceramics, which is responsible for the reduced strengths as well as such effects as fatigue and antifatigue.

**grindability index.** A measure of the grindability of a material under specified grinding conditions, expressed in terms of volume of material removed per unit volume of wheel wear.

**grinding.** (1) Reducing the particle size of a material by mechanical means. (2) Removing excess material from a workpiece by means of an abrasive wheel.

**grinding feed.** (1) The rate at which a material is fed automatically to a cylindrical grinder. (2) The rate at which solid material is introduced into a continuous pulverizing mill.

**grinding fluid.** An oil- or water-based fluid introduced into grinding operations to reduce and transfer heat during grinding, lubricate during chip formation, wash loose chips or swarf from the grinding belt or wheel, and chemically aid the grinding action or machine maintenance.

**grinding media.** The porcelain, flint, or steel balls, rods, rolls, and other materials used in grinding mills.

**grinding mill.** (1) Any machine, such as ball, tube, and rod mills, used to reduce the particle size of minerals, ceramic materials, cement clinker, and other solid substance for commercial and domestic use. (2) A lapidary lathe or wheel.

**grinding ratio.** The ratio of the volume of material removed from a workpiece to the volume removed from the grinding wheel.

**grit.** Crushed ferrous or synthetic abrasive material in various mesh sizes that is used in abrasive blasting equipment to clean castings. For materials used for grinding belts or grinding wheels, the term abrasive is preferred.

**grit number.** A number designating the particle size of grit grains based on sieve analysis.

**grit size.** Nominal size of abrasive particles in a grinding wheel, corresponding to the number of openings per linear inch in a screen through which the particles can pass.

**grog.** A ground mixture of refractory materials such as firebrick, clinkers, pottery, sand, saggers, crucibles, and the like added as raw material to refractories, saggers, acidproof ware, terra cotta, high-temperature porcelain, stoneware, vitreous china sanitary ware, sewer pipe, and similar products to improve working and service properties.

**ground coat.** The first coat of porcelain enamel applied to metal when subsequent coats are to be applied.

**ground coat boiling.** The undesirable evolution of gas during the firing of porcelain-enamel ground coat resulting in a variety of imperfections such as blisters, pinholes, black specks, dimples, or spongy surfaces.

**guide pin.** Device that maintains the proper alignment of force plug and cavity as the mold closes. Also called leader pin.

**gum.** Any of a class of colloidal substances exuded by or prepared from plants, sticky when moist, composed of complex carbohydrates and organic acids, which are soluble or swell in water. The term gum is sometimes used loosely to denote various materials that